WARNING

Because of possible shock or fire hazards, connection of this instrument should be performed in compliance with the National Electrical Code (ANSI C1) and/or any other requirements which may be applicable to the user.

Installation, operation, and maintenance should be performed only by qualified personnel.

TM-111650-1

VOLUME 1 - OPERATOR'S MANUAL

626-PA-6018

IMPULSE ENERGY MONITOR

NOTE

Refer to Volume 2 (Service Manual) of TM-111650 for maintenance data.

January 2, 1985
(Rev. 8/1/85)
(Rev. 5/1/86)
(Rev. 9/1/89)
(Rev. B)

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626-PA-6018 IMPULSE ENERGY MONITOR

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IMPORTANT! CALIBRATION INTERVAL

The recommended calibration interval for this unit is once every 12 MONTHS.

We recommend that you return the unit to the factory for calibration. If you decide to do so, first contact the Dranetz Customer Service Department to obtain an authorization number.

Telephone Number:	(201) 287-3680
Telex Number:	499-7808
TWX Number:	(710) 997-9553
FAX Number:	(201) 248-9240
Cable:	DRANETZ

Then fill out the Repair/Service Order form enclosed in this manual and ship it along with the unit to the Dranetz Customer Service Department. (If this form is missing, ask the Dranetz Customer Service Department for a replacement.)

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VOLUME 1
OPERATOR'S MANUAL

626-PA-6018 IMPULSE ENERGY MONITOR

SECTION I
GENERAL INFORMATION

1.1 SCOPE

This manual consists of two volumes labeled Volume 1 (Operator's manual), and Volume 2 (Service manual). Volume 1 is divided into three sections (I, II, and III)--GENERAL INFORMATION, INSTALLATION AND OPERATION, and OPERATIONAL TEST. Volume 2 contains the servicing instructions and consists of four sections which begin at Roman numeral IV and end with Roman numeral VII. (See Volume 2 for a description of these sections).

1.2 INTRODUCTION

This manual provides operating instructions for the 626-PA-6018 plug-in, referred to in this manual as the 6018. The 6018 is designed for installation in the Series 626 Universal Disturbance Analyzer Mainframe, referred to in this manual as the 626. These instructions are written under the assumption that the reader is familiar with the Mainframe information described in Volume 1 of the Mainframe manual.

1.3 PURPOSE

The 6018 is designed to monitor the energy content of impulses which are occasionally encountered on ac power lines.

1.3.1 Measured Parameters

Parameters measured for each impulse include: peak voltage, peak current, implulse duration, and impulse energy. Voltage is displayed in volts, current in amps, duration in microseconds (μ), and energy in joules.

1.3.2 Impulse Measurements

The main function of the 6018 is to determine the energy content, and thereby, the destructive potential of an impulse-type disturbance. For this reason, it measures closely grouped impulses (spikes) differently than other Dranetz plug-ins. Measured values are absolute (zero voltage referenced) rather than expressed as a deviation from the normally present 50 or 60 Hz power voltage waveform. Also, when several impulses of significant amplitude occur within a 20 millisecond time period, the 6018 treats them as a single impulse. The instrument's printout will indicate the combined total duration of the separate impulses along with their combined energies. This differs from other Dranetz plug-ins which usually read only the largest single impulse in a burst and ignore the smaller adjacent ones.

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1.3.3 Disturbance Detection

Both the current and voltage thresholds are user-selectable. When either threshold is exceeded, the impulse disturbance is detected and the built-in timer becomes activated. The disturbance is considered ended when both the voltage and current readings have fallen below their respective thresholds.

1.3.4 Threshold Selection

Voltage ranges, current ranges, and thresholds are each selected by using the front panel keyboard. The use of a menu and cueing indicators to point out the correct set of keys to choose from and the number of entries required, simplify the selection process. There is also a "factory preset" program built into the 6018 which may be recalled at any time by simply depressing the [PRESET] pushbutton.

1.4 APPLICATIONS

When used in a 626 Mainframe, the 6018 provides information on the energy level and propagation direction of power line impulses. Applications include:

a) Determining if the impulse energy levels (spikes) on a power line are large enough to cause damage to the electronic equipment being serviced by the line.

b) Estimating the size and clamp voltage of the surge suppressors required to protect the equipment from line impulses.

c) Calibrating and evaluating test equipment designed to simulate power line impulses for laboratory usage.

d) Testing and evaluating impulse suppression devices.

e) Determining the origin of power line impulses in order to aid in their reduction or elimination.

1.5 EQUIPMENT CHARACTERISTICS

The 6018 is configured as a plug-in module 6½" high by 1¼" wide by 10" deep. It is designed for installation in any one of the five slots of the Series 626 Universal Disturbance Analyzer. The 6018 is a single channel device which utilizes a clamp-on current probe. Technical specifications of the 6018 are presented in Table 1 on the following page.

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Table 1. 626-PA-6018 Impulse Energy Monitor, Technical Specifications

Impulse Energy Monitor — Technical Specifications

Parameters Monitored:	Peak voltage in V Peak current in A Duration in µSec* Energy in joules*
Impulse Voltage Ranges:	1000, 2000, & 4000 V FS
Impulse Current Ranges:	500, 1000, & 2000 A FS (Note: The 50/60 Hz line freq. current must not exceed 300 A rms on the monitored line).
Impulse Energy Ranges:	50, 100, 200, 400, & 600 joules F.S.
Impulse Duration Range:	999 µSec F.S.

Note: Voltage and current ranges are user-selectable while the power and energy ranges are automatically determined by the voltage and current range selections.

Impulse Characteristics:	1.0 to 999 µSec Rise or Fall time. 2.0 to 1000 µSec duration.
Ringing Transient Characteristics:	10 to 500 kHz ring frequency. 5 to 999 µSec duration.
Threshold Settings:	25 to 2000 volts. 12 to 1000 amps.

Note: Either a voltage or current threshold out-of-limits will trigger a measurement. The measurement will cease when both the voltage and current are again below their respective threshold limits.

Impulse Voltage Accuracy:	±5% of reading ±1% FS for ½ sinewave pulses ≥ 10 microseconds in duration. A typical error is -6 dB at 1 µSec duration.
Impulse Current Accuracy:	±5% of reading ±1% FS for ½ sinewave pulses ≥ 10 microseconds in duration. A typical error is -6 dB at 1 µSec duration.
Duration Accuracy:	±5% of reading ±.3% FS*
Energy Accuracy:	±10% of reading ±1% FS for ½ sinewave pulses ≥ 10 microseconds in duration. A typical error is -6 dB at 2 µSec duration.*

* Duration and energy measurements are made during the entire time in which an impulse is above either the voltage or current threshold limits.

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1.6 ACCESSORIES

1.6.1 Standard Accessories

Part No.	Quantity	Description
TM-111650, Vol. 1	1	Operator's Manual
TR-2019	1	Clamp-on Current Pro

1.6.2 Optional Accessories

Part No.	Quantity	Description
TM-111650, Vol. 2	1	Service (Maintenanc Manual

1.7 FACTORY REPAIR

When factory repair is required, proceed as follows:

1. Contact the Dranetz Customer Service Department in or to obtain an authorization number for factory repair.

   Telephone No: (201) 287-3680

   TWX: (710) 997-9553

   FAX: (201) 248-9240

   Telex: 499-7808

   Cable: DRANETZ

2. Fill out the REPAIR/SERVICE ORDER form enclosed in the Series 626 Operating manual. Ship it along with the malfunctioning equipment to the Dranetz Customer Servi Department.

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SECTION II
INSTALLATION AND OPERATION

2.1 INSTALLATION

To install the 6018 into the Mainframe, proceed as follows:

> **CAUTION**
>
> Be sure that the 626 Mainframe and all of the power connected to its modules is first turned OFF.

a) Position the top and bottom corners of the 6018 module into the upper and lower tracks of the desired slot position at the rear of the Mainframe.

b) Carefully slide the module into the Mainframe until it is firmly seated.

c) Tighten the top and bottom captive screws in order to secure the module to the Mainframe.

2.1.1 Load Ratings

The 626 standard Mainframe has an upper limit of the combined total rating of the installed modules. The overall Mainframe capacity is set at 20 units. The individual modules (existing at the date of this printing) have the following load ratings:

Plug-in	Load Rating	Plug-in	Load Rating
626-PA-6001	2 Units	626-PA-60012A	3 Units
626-PA-6001 with Extra Option Board	3 Units	626-PA-6013	2 Units
		626-PA-6014	1 Unit
		626-PA-6015	4 Units
626-PA-6002	2 Units	626-PA-6018	4 Units
626-PA-6003	4 Units	626-PA-6020	4 Units
626-PA-6005	2 Units	626-PA-6024A	4 Units
626-PA-6006	2 Units	626-PA-6024B	4 Units
626-PA-6007	1 Unit	626-PA-6025	4 Units
626-PA-6008	2 Units	626-PA-6030	6 Units
626-PA-6009	4 Units	626-PA-6037	1 Unit
626-PA-6011	1 Unit	626-PA-6038	1 Unit
626-PA-6012	2 Units	626-PA-6040	6 Units

NOTE

When selecting modules for installation into any 626 Mainframe, verify that the sum of the load ratings of its installed modules DOES NOT exceed 20 Units.

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2.2 INSTALLATION GUIDELINES

CAUTION

To avoid damaging the equipment, DO NOT apply ac voltage in excess of 600 V rms to the 6018.

WARNING

Because of possible shock or fire hazards, connection of this instrument should be performed in compliance with the National Electric Code (ANSI C1) or any other requirements which may be applicable to the user.

The 6018 is supplied with a barrier type terminal strip under a small cover. To connect, proceed as follows:

a) Turn OFF the ac power to the line that is going to be monitored.

b) Insert the key into the FUNCTION keyswitch on the front panel of the Mainframe. Turn the key counterclockwise to the "OFF" position if it is not already in such a position.

c) Remove the terminal strip safety cover in order to expose the connections. Now, connect the single phase line to the three terminals such that the two ac leads are connected to the upper two terminals and the earth ground is connected to the third terminal (see figure 1 on the following page for the polarity required in order to provide the correct sign (±) on the impulse energy printout). When all of the connections have been made, be sure to replace the terminal block cover, then, reapply the ac power.

2.3 OPERATING CONTROLS AND INDICATORS

Figure 2 on page 2-4 shows the typical front panel layout of the controls on a Series 626. The functions of the Mainframe operating controls and indicators associated with 6018 operation are described in Table 2 on page 2-5. For a description of the controls common to overall Model 626 operation, refer to Volume 1 of the Mainframe manual.

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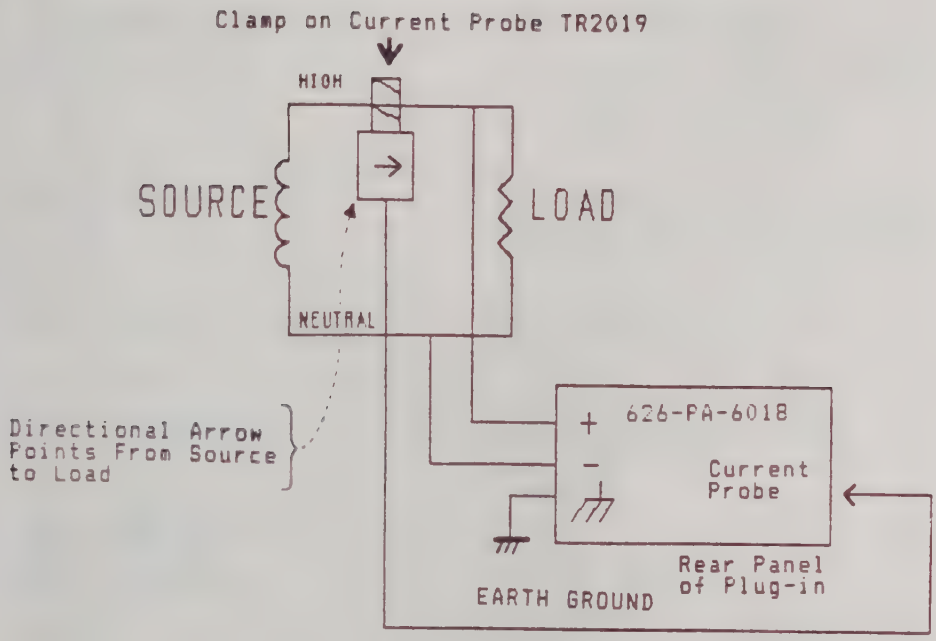

Figure 1. Proper Connections of the 626-PA-6018 with the TR2019 Current Probe.

e call-outs on Figure 2 illustrate the controls on the 626 Mainframe ed by the 6Ø18 when this plug-in is installed therein. Front panel ntrols and indicators which are common to overall 626 operation are scribed in Volume 1 of the Mainframe manual.

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The 6018 utilizes a menu-style format for selecting items and thresholds. The menu is accessed by using the numeric keypad on the front panel of the Mainframe.

Table 2. 626-PA-6018 Operating Controls

Item	Function
Numeric Keypad *	1. To select an item from menu. 2. To enter the voltage and current thresholds.
Numeric Keypad LEDs	The number of LEDs illuminated indicates the number of digits required for a complete entry.
[ENTER] key *	When depressed, transfers the numeric keypad entry into memory.
[DATA] pushbutton	When depressed, produces a Data Summary printout (assuming that the FUNCTION switch is set at "OPERATE").
[PROG] pushbutton	When depressed, produces a Program Summary printout (assuming that the FUNCTION switch is set at "OPERATE").
[PRESET] pushbutton	When depressed, returns all of the programmed parameters to their "factory preset" values for the selected channel number (assuming that the FUNCTION switch is set at "PROGRAM").
ALL OTHER FRONT PANEL CONTROLS AND INDICATORS	Refer to Volume 1 of the Mainframe Manual.

2.4 PROGRAMMING PROCEDURE

Select the channel number to be programmed by using one of the five numerated black pushbuttons located just below the red and yellow keypads. Turn the FUNCTION key clockwise to the "PROGRAM" setting. The following message will then be printed (see the following page):

---

* -The terms key and keypad represent the green and yellow keys. The term pushbutton represents the black selector buttons.

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626

```
SELECT MENU <ITEM>
******************

<7>  I THRESHOLD
<6>  V THRESHOLD
<5> 2000 A RANGE
<4> 1000 V RANGE
<3>  500 A RANGE
<2> 4000 V RANGE
<1> 2000 V RANGE
<0> 1000 V RANGE
<PRESET>

***** MENU *****

I THRESHOLD 0200 A
V THRESHOLD 0400 V
E RANGE      200 J
I RANGE     1000 A
V RANGE     2000 V
   626-PA-6018
       CH #
 PROGRAM SUMMARY

    PROGRAM MODE
```

626A,G,R,ARA

```
 PROGRAM MODE

 PROGRAM SUMMARY
       CH #
   626-PA-6018
V RANGE     2000 V
I RANGE     1000 A
E RANGE      200 J
V THRESHOLD 0400 V
I THRESHOLD 0200 V

 ***** MENU *****

<PRESET>
<0> 1000 V RANGE
<1> 2000 V RANGE
<2> 4000 V RANGE
<3>  500 V RANGE
<4> 1000 V RANGE
<5> 2000 A RANGE
<6>  V THRESHOLD
<7>  I THRESHOLD

*****************
       SELECT MENU <ITEM>
```

2.4.1 Program Summary Printout

The Program Summary Printout indicates the present settings of all programmable items. A single yellow LED will be illuminated indicating that a single numerical entry is required. The "SELECT MENU <ITEM>" portion of the printout shows the items which may be programmed and their corresponding numerical entry "[#]" required for selection.

Note: Be sure to select the V & I ranges before attempting to enter the thresholds.

2.4.2 Selecting V & I Ranges

In order to select a V or I range, depress the single numerical key which corresponds to the desired range indicated by the menu.

Example: Depressing [2], selects a 4000 volt range for the V threshold.

2.4.3 Energy Range

The energy range is not independantly selectable by the operator. Instead, whenever a combination of V & I ranges is selected by the operator, the energy range is automatically set by the 6018 to a range compatible with the V & I ranges selected.

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2.4.4 V & I Threshold Invalidity

If a previously selected V & I threshold is not valid on the V or I range selected, the threshold will automatically be changed to its "factory preset" value. Any range or threshold changes are indicated by the printer.

Note: If continuous impulse printouts are generated, increasing either the voltage or current thresholds (or both) should correct this condition.

2.4.5 Changing Threshold Entries

In order to change the V threshold, use the [6] key as indicated by the menu. The [7] key is used for changing the I threshold. When either of these keys is depressed, 3 or 4 yellow LEDs will illuminate indicating the number of digits required to complete the entry. One LED will go out every time a digit is depressed. If an error is made in the entry, depress the [CLEAR ENTRY] key. All of the numerals entered will be cleared and each of the LEDs will re-illuminate. The correct entry may now be entered.

2.4.6 Entering Thresholds into Memory

When all of the required digits have been entered, the green LED located next to the [ENTER] key will illuminate. If the entry is correct, depress the [ENTER] key in order to load it into memory. If the entry is still incorrect, the [CLEAR ENTRY] key will again clear it. If the entered threshold is either too low or too high for the range selected, it will be so indicated by the printer with the following message:

"ENTRY TOO HIGH"

When such a message is printed, all applicable LEDs will re-illuminate in order to indicate that another threshold may now be entered.

2.4.7 Completion of the Plug-in Program

When the plug-in program is completed, the operator may proceed to program another module (by depressing another channel number), or the operator may place the instrument on-line by turning the FUNCTION key counterclockwise to the "OPERATE" position. While on line, the program in effect may be obtained by simply depressing the [PROG] pushbutton.

2.5 SELECTING THE FACTORY PRESET PROGRAM

To select the program stored in hard-memory, depress the appropriate channel number pushbutton and then turn the FUNCTION key to "PROGRAM". The printer will automatically print a summary of the existing programming and menu. Next, depress the [PRESET] button in order to recall the "factory preset" program. An example of the printout for this sequence appears on the following page:

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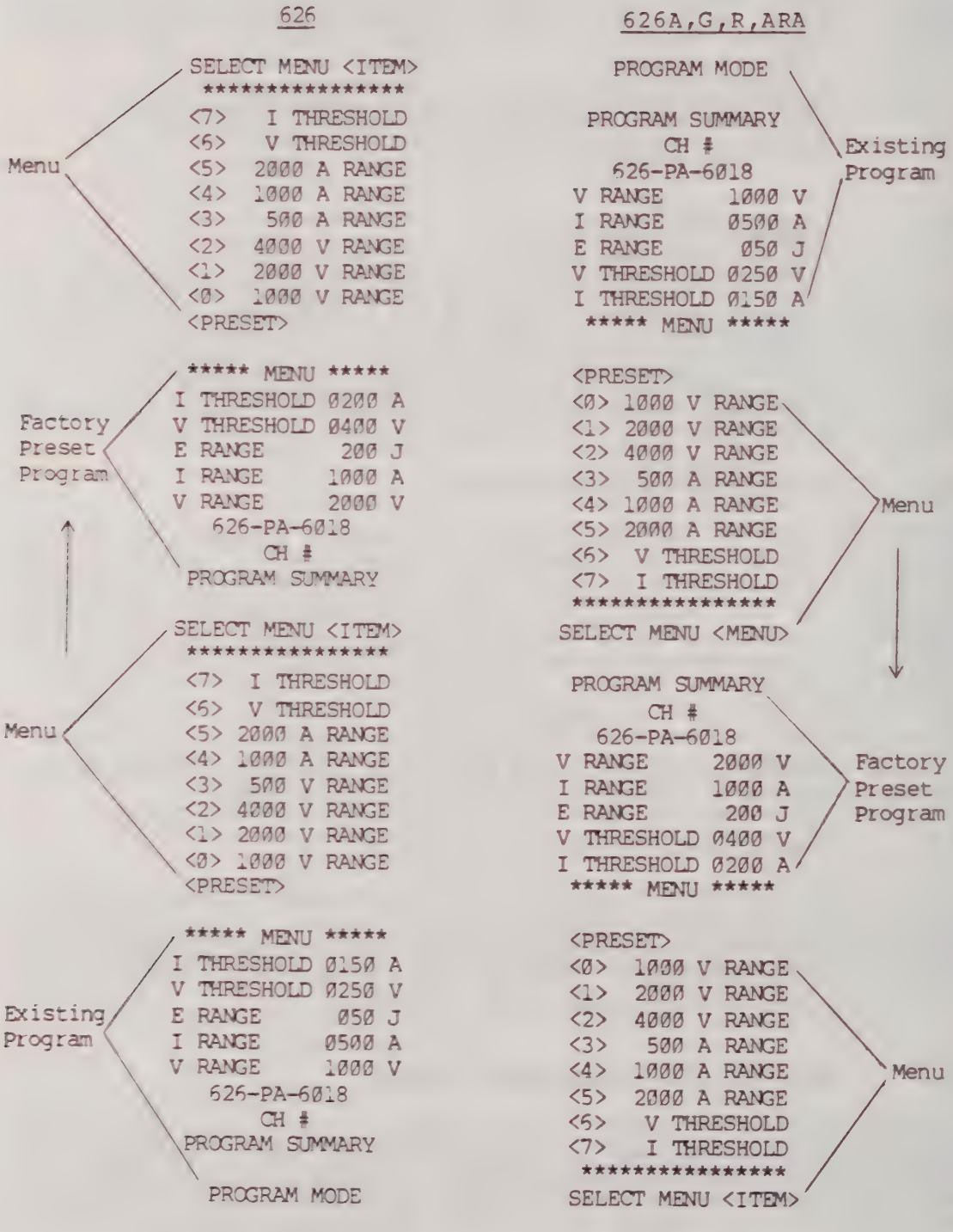

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2.6 DESCRIPTION OF DATA PRINTOUT

If the FUNCTION switch is in the "OPERATE" position, and the PRINTOUT MODE switch is in a setting other than the "SUMMARY ONLY" or "SYSTEM CHECK" position, the following is printed when either the voltage or current exceed their respective thresholds:

```
3 IMP   11:48:17.60
  0386 V    0390 A
 -006.9 J   092 US
```

where:

"3" — is the channel number.

"IMP" — is the description of the impulse event.

"11:48:17.60" — is the time that the event occurred in hours, minutes, seconds, and hundredths of a second.

"0386 V" — is the peak value of the impulse voltage in volts.

"0390 A" — is the peak value of the impulse current in amperes.

"-006.9 J" — is the total energy transferred past the point of measurement during an impulse event.*

"092 US" — is the total duration of the impulse event in microseconds.

* The "-" sign preceding the numerical value indicates the direction of energy transfer (in this case from load to source) if polarity conventions were observed when connecting the voltage inputs and installing the current probe.

NOTE: Be aware of the following operating characteristics of the 626-PA-6018 when interpreting any results:

a) The Voltage measurement is the absolute peak magnitude of the Voltage appearing between the "+" and "-" terminals of the input connector. Unlike several other plug-ins, the 6018 does not filter out the power line frequency components of the voltage waveform. This is because the energy transfered during an impulse is dependent upon where in the line frequency waveform the impulse occurs.

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b) The current measurement is the absolute peak magnitude of the current flowing through the line on which the probe is clamped. Again, as with the voltage, the power line frequency components of the waveform are not filtered out.

c) Energy is the net total energy transfered during an impulse or series of impulses occuring within a 20 millisecond interval. When an individual impulse occurs, the energy is measured during the time period in which either the voltage or current waveforms exceed their respective thresholds. When a burst of impulses or a ringing waveform is measured, energy is accumulated during the total time in which a threshold is exceeded for an elapsed time of up to 20 milliseconds.

d) Duration is the total time in which either the voltage or current waveforms exceed their respective thresholds.

For Example: If a 50, 90, and 300 microsecond impulse all occur within a 20 millisecond time interval, the printout will indicate that a duration of 440 microseconds has occured.

e) If any parameter exceeds its full scale range limit, a ">" symbol is printed directly before the numerical value. The following is an example where the voltage exceeded its full scale range limit:

Since the energy value printed is derived from the voltage and current, an overrange in either the voltage or current indicates that the energy printed is below its true value. This is true even if the energy itself is well below its full scale range limit as is evidenced above.

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SECTION III
OPERATIONAL TEST

3.1 GENERAL

This section provides information for performing an Operational Test to verify that the 6018 is operating properly.

3.2 INTERNAL DIAGNOSTICS CHECK

The 6018 contains internal-pulse-generating facilities which may be used to verify the accuracy of impulse voltage, current, duration, and energy measurements. The correct operation of the voltage and current thresholds may also be verified without external testing equipment. This is because all of the plug-in's circuitry (with the exception of the input connectors, attenuators, and differential amplifiers) may be excercised by the self-contained test facilities.

3.3 SYSTEM SELF-CHECK PROCEDURE

When the PRINTOUT MODE keyswitch is turned to the "SYSTEM CHECK" position, the voltage and current input amplifiers are disconnected from their pre-amplifiers and a calibrated waveform is applied to each. The printout generated by these signals verifies the proper operation of approximately 90% of the circuitry of the 6018. A typical SYSTEM CHECK printout is illustrated below:

626	626A,G,R,ARA
**********	***SYSTEM CHECK***
Ø498 V Ø400 A	Ø7/18/84 16:42:55
-Ø18.8 J Ø99 US	
626-PA-6Ø18	CH 3
CH 3	626-PA-6Ø18
	-Ø18.8 J Ø99 US
Ø7/18/84 16:42:55	Ø498 V Ø400 A
SYSTEM CHECK	**********

If the SYSTEM CHECK is performed with the "factory preset" program, accuracy limits are as follows:

Voltage:	455 to 545 volts
Current:	370 to 430 amps
Energy:	16.0 to 24.0 joules
Duration:	92 to 108 microseconds

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3.3.1 System Check without the "Factory Preset" Program

The SYSTEM CHECK may also be run at conditions other than the "factory preset" program. If this is done, the 6018 will respond as if a 500 volt, 400 amp, 100 microsecond, approximately square impulse has been applied to the input. Voltage and current readings will be accurate to within ±5% of reading ±1% F.S. Energy and duration will remain at ±10% of reading ±1% F.S. and ±5% of reading ±0.3% F.S. respectively, as long as the V & I threshold values are not changed from their "factory preset" values. Inceasing the thresholds will cause smaller duration and energy readings since the test impulse has sloped rising and falling edges. If both thresholds are increased above their respective input levels, the following message is printed for SYSTEM CHECK:

626	626A,G,R,ARA
**********	***SYSTEM CHECK***
T'HOLD > CAL PULSE	Ø7/24/84 16:55:Ø3
626-PA-6Ø18	CH #
CH #	626-PA-6Ø18
Ø7/24/84 16:55:Ø3	T'HOLD > CAL PULSE
SYSTEM CHECK	**********

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APPENDIX A

A.1 INTRODUCTION

The following appendix is provided as an addendum to Volume 1. Described herein are some of the finer points of the 6018 operation.

A.2 PURPOSE

This appendix provides additional information to assist the operator of the 6018 in obtaining valid measurements under field use conditions.

A.3 DEFINITION OF IMPULSE ENERGY

Measurement of impulse energy is performed by observing both the Voltage and Current waveforms of an impulse, and then calculating the following:

$$\text{Energy} = \int_{t1}^{t2} V(t)\, I(t)\, dt$$

where: V(t) -- is the voltage of the High side of a single phase line with respect to the Neutral.

I(t) -- is the current flowing in the High side of the line from the Source to the Load.

t1 -- is the start of the impulse (V or I threshold exceeded).

t2 -- is the end of the impulse (both V & I below their threshold values).

Energy will be indicated as positive when the direction of propagation is from Source to Load, and negative when the direction of propagation is from Load to Source.

A.4 THRESHOLD SELECTION

Because both the voltage and current waveforms are significant in the determination of impulse energy, individual user-selectable thresholds are provided for each of these parameters.

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A.4.1 Voltage Threshold Selection

When selecting threshold Voltage, the user should be aware that the measurement band-width of the 6018 includes the 50/60 Hz power frequency range; therefore, a threshold voltage setting higher than the peak value of the line frequency Voltage is required.

For example: On a 115 volt line, a voltage threshold of 200 volts might be selected. The reasoning for the 200 volt selection is as follows:

a) V max = 110% of V nominal = 126.5 V rms

b) Allow 10% for voltage surges; therefore:
V' max = 1.1 x 126.5 = 139 V rms

c) Vpk = $\sqrt{2}$ x V rms; therefore: Vpk = 1.414 x 139 = 197 V rms

A.4.2 Current Threshold Selection

Note: Selection of an appropriate current threshold is more complex than voltage threshold selection for the following reasons:

a) There is no conveniently specified nominal current flow in a given line.

b) Current waveforms are often distorted and this prevents the peak/rms ratio from being known.

c) Many Loads require starting currents which are significantly higher than their normal running currents.

Taking these three factors into account, the user might select a current threshold as follows:

a) For a line rated at 20 amps, the nominal load is therefore less than 20 amps.

b) The Peak starting current or distortion or both could be 5 to 7 times the actual line rating.

c) Therefore, let the threshold be greater than or equal to 7 x 20 = 140 amps.

A.4.3 Continuous Impulse Printouts

When continuous impulse printouts are generated, the probable cause is that the system is being triggered by the voltage or current peaks of the power line waveform. If this is the problem, increasing either the voltage or Current thresholds or both should correct this condition.

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A.5 626 POWER SUPPLY CONNECTION

Whenever practical, the 626 should be powered from a line other than the one which is being monitored. If the 626 must be powered from the monitored line, its power cord should be connected on the Source side of the point being monitored. If the power cord is connected on the Load side, a portion of the impulse energy measured would be that which is being delivered to the 626 power supply. When powered from the Source side, the 626 may still alter the test results because its power supply tends to limit and absorb line-to-line impulses. This effect would be most significant on a lightly loaded line. Where considerable amounts of electronic equipment are already connected to a line, the additional limiting effects of the 626 power supply are less likely to be significant.

A.6 INTERPRETING THE RESULTS

Impulse energy measurements remain valid as long as the monitored system remains unchanged. While this statement is true regardless of the measured parameters, its effects are more evident for impulse current and energy measurements than for impulse voltage measurements.

A.6.1 Cautions Regarding Possible Result Misinterpretations

The most obvious error would be to attempt a pre-installation site survey on an unloaded dedicated power line. Although there may be significant impulse voltage activity, little current will flow in the line because there are no Loads yet connected. Without current flow, impulse energy will be zero, leading one to incorrectly assume that the Loads which are going to be connected will not need protection.

There are other misinterpretation possibilities for impulse energy readings. These are less obvious and therefore more likely to cause misunderstandings. If an impulse of a given amplitude is generated by a Source having a fixed impedance, the energy it delivers to a Load is a function of all parameters in the following figure:

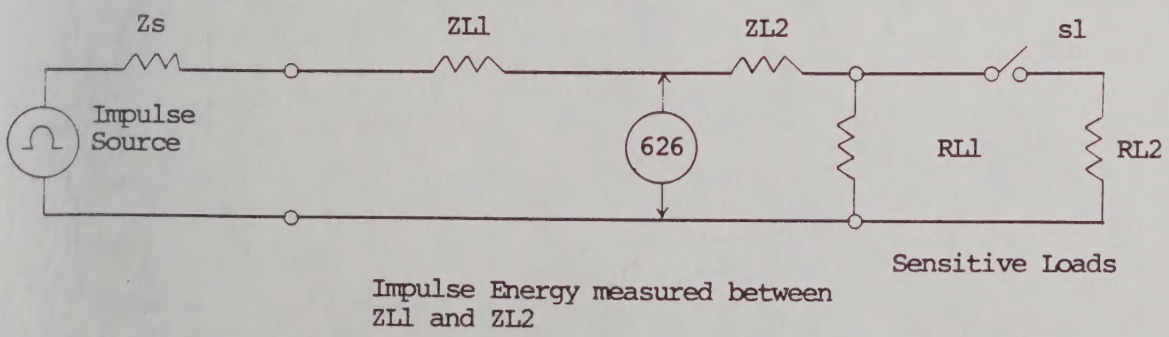

Figure 3. A Typical Equivalent Circuit.

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The table below provides an insight into the changes which would occur following any alterations which could be made to the circuit of figure 3. The table also relates the measurements made before the change to the measurements made afterwards.

TABLE 3
626-PA-6018
Alteration Measurement Changes

CHANGE DESCRIPTION AND CAUSE	626-PA-6018 READING CHANGES	CHANGES AT RL1
Line impedance ZL1 reduced (improved wiring)	V increases I increases E increases	V increases I increases E increases
Line impedance ZL2 increased (Isolation transformer added)	V increases I decreases E increases or decreases	V decreases I decreases E decreases
Load impedance decreased (Close s1 to connect RL2)	V decreases I increases E increases or decreases	V decreases I decreases E decreases
Load impedance made non-linear (Transient Suppression added at RL1)	V decreases I increases E increases or decreases	V decreases I decreases E decreases

An inspection of Table 3 reveals that impulse energy changes at a sensitive Load are easier to predict than changes in the measured readings at the point being monitored. In other words, the most useful impulse energy information is that which is obtained by measuring as close to the sensitive Load as possible. If a Load can be isolated from the others and monitored individually, then the energy dissipated by it alone can accurately be determined and the effects of changes in the system can best be estimated.

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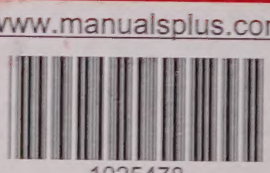

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